

CLINICAL EVALUATION OF THE PROPHY-JET™ IN ROUTINE PLAQUE  
DEBRIDEMENT OF ORTHODONTIC PATIENTS

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL  
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I thank my wife Jacque for all of her support, patience, and sacrifices through my many years in school. I look forward to our future together and all that it will bring.

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Abstract of Thesis Presented to the Graduate School  
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Chair: Timothy T. Wheeler  
Major Department: Orthodontics

Orthodontic appliances, specifically brackets bonded to teeth, can accumulate plaque, leading to gingivitis, enamel decalcification, and dental decay. Currently, plaque removal in the orthodontic office is limited to tooth-brushing after wire removal.

A prospective randomized clinical trial was conducted to compare the effectiveness of the Prophy-Jet™ to that of tooth-brushing for removing dental plaque and for maintaining oral health. We recruited 40 orthodontic patients with fixed appliances showing poor oral hygiene to participate in the 6-month study. Patients were randomly assigned to have one side of their mouth to be cleaned monthly with the Prophy-Jet™; the contralateral side was brushed by the patient. Plaque Index (PI), Papillary Bleeding Score (PBS), and Decalcification Index (DI) were assessed throughout the study.

Significantly lower mean PI scores after cleaning were found for the Prophy-Jet™ (0.41 maxillary posterior, 0.08 maxillary anterior, 0.23 mandibular posterior, 0.05

mandibular anterior) versus tooth-brushing (1.85 maxillary posterior, 2.08 maxillary anterior, 1.64 mandibular posterior, 1.78 mandibular anterior). Monthly PI and PBS scores were not significantly different. However, changes in DI scores were significantly less for the Prophy-Jet™ teeth (mean difference= 0.27 mandibular posterior, 0.37 maxillary anterior, 0.18 mandibular anterior).

Results show that the Prophy-Jet™ was more effective than tooth-brushing at removing dental plaque for a single session. In addition, monthly cleanings with the Prophy-Jet™ were found to decrease the progression of enamel decalcifications in patients with inadequate oral hygiene practices between visits.

## INTRODUCTION

Dental plaque has long been associated with dental decay and periodontal disease. Fixed orthodontic appliances, specifically brackets bonded to teeth, can accumulate plaque along their margins with teeth; and may interfere with effective plaque removal. In addition, proper oral hygiene by these patients, while crucial to successful treatment, can be difficult to maintain. Accumulated dental plaque in orthodontic patients has been associated with enamel decalcification, enamel scarring, dental decay, and gingivitis. In a study of decalcification incidence, 50% of orthodontic patients experienced an increase in decalcification during treatment, with the highest incidence in the maxillary incisor region and lowest incidence in the maxillary posterior region.<sup>1</sup>

Professional dental prophylaxis over the years has traditionally involved the use of a rubber cup and abrasive paste for coronal polishing. The ultimate goal of this procedure is complete removal of supragingival plaque and stain. However, the use of rubber cup and abrasive paste is often laborious, time-consuming, and ineffective in completely removing supragingival deposits, particularly around bonded orthodontic appliances.

Since its introduction to the dental marketplace in 1977, air-powder polishing systems have been effective at removing stain and plaque.<sup>2</sup> The design of the various air-powder polishing systems, such as Dentsply's Prophy-Jet™, use a mixture of air, water, and sodium bicarbonate to deliver a controlled stream of sodium bicarbonate particles to the tooth surface. This slurry of powder and water debrides tooth surfaces of

plaque and stain by abrasion. Advantages of air polishers are rapid removal of tooth deposits, less invoked hypersensitivity;<sup>3,4</sup> less operator fatigue;<sup>5</sup> and improved access to pits and fissures.<sup>6</sup> In a survey of 140 stain patients, 94% preferred the Prophy-Jet™ compared to hand instrumentation or ultrasonic scaling.<sup>7</sup> Reasons cited by the patients were that the Prophy-Jet™ was more thorough, it required less chair time, and it was more comfortable because no heat, scratching, or pressure were generated during the prophylaxis.

Currently, plaque removal in the orthodontic office is limited for mainly to tooth-brushing after wire removal. This method of plaque removal requires wire removal and often relies on the patient's ability to effectively remove the plaque with a manual tooth-brush. While the Prophy-Jet™ has been shown to be effective in general dental patients, its long-term effectiveness on orthodontic patients has never been studied.

By designing a study that includes long-term follow-up on the periodontal and dental health of orthodontic patients, the potential benefits of routine Prophy-Jet™ cleanings could be explored not only for a single visit, but as a regimen for oral health maintenance for orthodontic patients with oral hygiene concerns.

The purposes of this clinical trial were as follows:

- To evaluate the efficacy of the Prophy-Jet™ in removing dental plaque in orthodontic patients with arch-wires in place;
- To evaluate the long-term effects of monthly debridements with the Prophy-Jet™ in orthodontic patients with poor oral hygiene on gingivitis, decalcification, and plaque accumulation;

- To compare the effectiveness of the Prophy-Jet™ to currently used method of tooth-brushing.

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## MATERIALS AND METHODS

This study was designed as a prospective randomized controlled clinical trial. Patients undergoing orthodontic treatment with brackets and wires in the maxillary and mandibular arches were recruited from the Graduate Orthodontic Clinic at the University of Florida College of Dentistry. Other selection criteria for inclusion in the trial were the presence of extensive amounts of visually detectable plaque around the orthodontic appliances as identified by the operator, good health with no current medications, and willingness to sign informed consent. Patients were instructed to restrict home care to floss and manual tooth-brushes; and were not allowed the use of any electric tooth-brushes. The Institutional Review Board for research at the University of Florida approved the study protocol before the study was begun.

Participants in the study were randomly assigned a side of the mouth that would be cleaned monthly by the Dentsply Prophy-Jet™ instrument for the duration of the 6-month study. The contralateral side was manually brushed by the patient at each clinical visit. This randomization was created from a computer-generated sequence that was followed for patient assignment. A mouth tray was placed on the tooth-brush side of the mouth while using the Prophy-Jet™ to prevent crossover spray. For participation in the trial, patients were financially compensated and received a full mouth debridement with the Prophy-Jet™ at completion of the study.

The protocol for each clinical visit was designed based on a pilot study that was conducted in 1999 at the University of Florida. This pilot study showed the effectiveness

of debridement with the Prophy-Jet™ with arch-wires in place; therefore, arch-wires were not removed for the present study. Patients were seen for a total of seven clinical visits, the first consisting of a baseline examination of dental health parameters including the collection of clinical indices. At this initial visit, Prophy-Jet™ cleaning on the assigned side and manual tooth-brushing on the contralateral side were performed, with 30 seconds allotted per arch for each method to make procedure time comparable. Patients were then seen at monthly intervals for 6 months, at which times clinical indices were recorded and the split-mouth cleaning was performed.

The labial surfaces of teeth bonded with brackets from the 2<sup>nd</sup> premolars forward were included in this assessment. The following clinical indices were measured for this study.

**Plaque.** Plaque levels were assessed using the Turesky modification of the Quigley-Hein Plaque Index (PI).<sup>8</sup>

0 = No plaque visible

1 = Separate flecks of plaque visible at the gingival margin

2 = A thin continuous band of plaque (up to 1 mm) at the gingival margin

3 = A band of plaque wider than 1 mm but covering less than one-third of the tooth surface

4 = Plaque covering at least one-third but less than two-thirds of the surface

5 = Plaque covering more than two-thirds of the surface

The PI was recorded at each monthly visit. In addition, the PI before and after cleaning was scored at the baseline visit to compare mechanical cleaning effectiveness of the Prophy-Jet™ to that of manual tooth-brushing under the clinical conditions of the study.

**Decalcifications.** Decalcifications were assessed visually and tactilely with a dental explorer and scored by using a modified version of the white spot lesion index of Gorelick et al.<sup>1</sup>

- 0 = No white spot present
- 1 = Visible white spots without surface interruption (mild decalcification)
- 2 = Visible white spot lesion having a roughened surface but not requiring a restoration (moderate decalcification)
- 3 = Visible white spot lesion with surface interruption (severe decalcification)
- 4 = Cavitation

The decalcification index (DI) was measured at baseline, 3 months, and 6 months due to the slow, progressive nature of decalcifications.

**Gingivitis.** Gingivitis was assessed at each monthly visit using the Papillary Bleeding Score (PBS) of Loesche.<sup>9</sup> A Stimu-dent™ was used to stimulate the interdental papilla, which is a common site of gingival inflammation for orthodontic patients. Subsequent gingival bleeding was used as a measure of gingival health.

- 1 = No bleeding
- 2 = Slight bleeding
- 3 = Bleeding with flow
- 4 = Intermediate bleeding (copious)
- 5 = Spontaneous bleeding

A single operator performed all measurements and cleanings; thus, blinding was not possible for the decalcification index, which was recorded after cleanings. Before recruitment of patients for the Prophy-Jet™ study, the operator was calibrated by a calibrated dental hygienist on the three clinical indices (DI, PI, and PBS) and use of the Prophy-Jet™ to ensure consistency of results. Five orthodontic patients meeting the inclusion criteria of the planned study were examined by operator and hygienist and standardization and reproducibility of indices were demonstrated. These patients were not included in the clinical trial.

Forty patients were recruited to participate in the study. The mean age was  $18.1 \pm 9$  y (range 11 to 56 y). The group was composed equally of 20 males and 20 females. In reference to use of a dominant hand, 35 patients were right-handed and 5 patients were left-handed. The assignment of sides of the mouth to be cleaned with the Prophy-Jet™ was 20 for the right side and 20 for the left side. For the right-handed subjects, 17 had Prophy-Jet™ on the left and 18 had Prophy-Jet™ on the right; for left-handed subjects, 3 had Prophy-Jet™ on the left, and 2 had Prophy-Jet™ on the right. Over the course of the 6-month study, 5 patients were eliminated for missing appointments or discontinuing orthodontic treatment. Thirty-five patients successfully completed the study and were seen at all seven clinical visits.

Each patient served as a control: one assigned side of the mouth was cleaned by the Prophy-Jet™ for the duration of the 6 months. Changes that occurred during treatment for PI, DI, and PBS on the two treatment sides were evaluated with the paired t-test and the 2-sample t-test. Pearson correlation coefficients were used to evaluate for relationships within the data set.

## RESULTS

The difference in mean reduction in PI scores at the baseline visit (Figure 1) between the Prophy-Jet™ and tooth-brush was statistically significant for all four quadrants, with the Prophy-Jet™ having greater PI reduction ( $p < 0.0001$ ). A sample comparison of the cleaning effectiveness between the Prophy-Jet™ and manual tooth-brushing at the baseline visit is illustrated in Figure 2.

Change in DI scores from baseline to 6 months were significantly lower for the Prophy-Jet™ for the mandibular anterior and posterior, and the maxillary anterior ( $p < 0.05$ ). The maxillary posterior did not reach statistical significance ( $p = 0.26$ ). The mean DI scores are shown in Figure 3, and the differences between the two sides (with a positive number indicating less decalcification increase for the Prophy-Jet™) are shown in Figure 4. Figure 5 shows a sample photo comparison of both sides. Mean DI score change did not differ significantly by gender or side of mouth selected for Prophy-Jet™ use.

Plaque index (PI) changes from baseline to 6 months are shown in Figure 6 and did not reach statistical significance ( $p = 0.07$ ). Patient gender did not influence PI scores; however, patients who received the Prophy-Jet™ cleanings on the left side of their mouth had a significantly greater difference in plaque levels between the two sides (mean =  $0.46 \pm 0.52$ ) than those assigned to the right side (mean =  $0.00 \pm 0.80$ ).

Papillary Bleeding Score (PBS) changes from baseline to 6 months were not significantly different ( $p = 0.46$ ) and are shown in Figure 7. Mean PBS score change did not differ by gender or side of mouth selected for Prophy-Jet™ use.

Analysis via Pearson correlation coefficients (Table 1) indicated statistically significant correlations of the changes in clinical indices between the Prophy-Jet™ and tooth-brush sides. DI, PI, and PBS were positively correlated between the two sides ( $p < 0.005$ ). In addition, for the Prophy-Jet™ side, changes in DI were positively correlated with changes in PI ( $p < 0.05$ ).

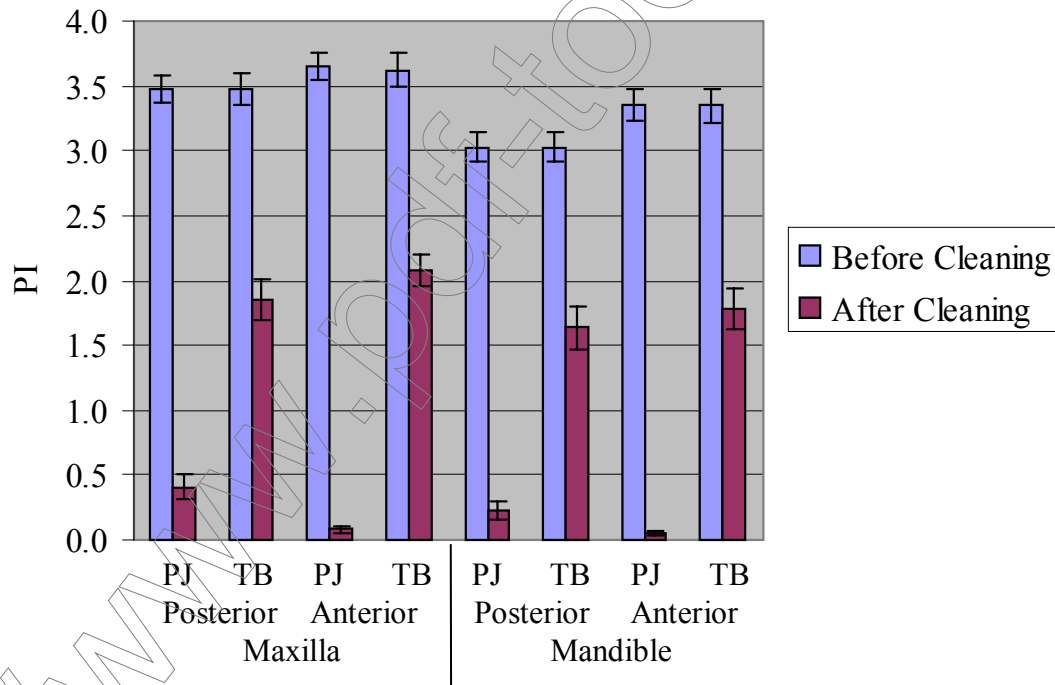


Figure 1. Plaque Index scores (mean  $\pm$  SE,  $n = 40$ ) before and after cleaning at baseline visit, by region. (PJ = Prophy-Jet™, TB = tooth-brush).

\* Significant at  $p < 0.0001$

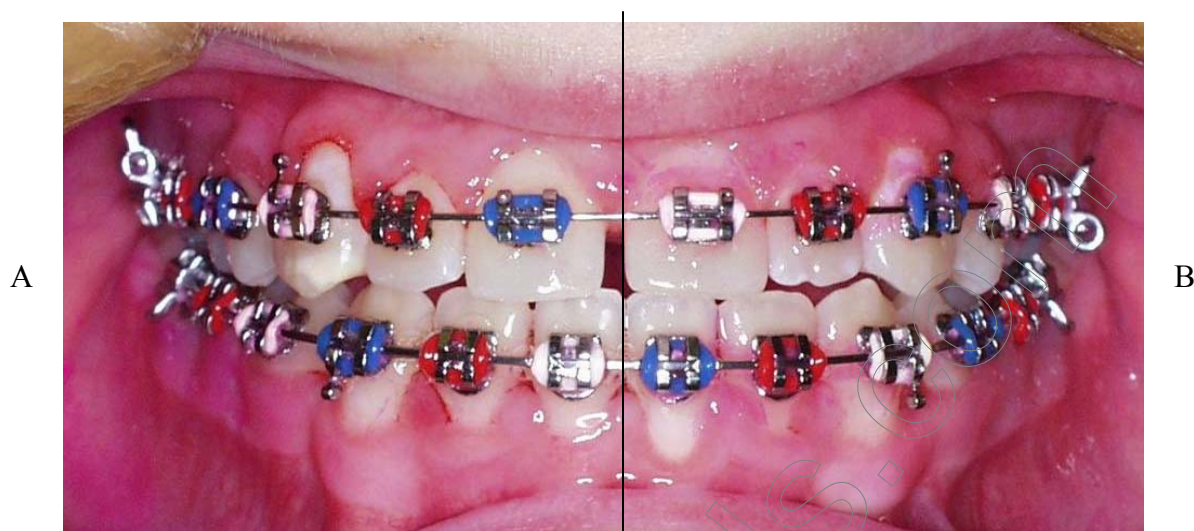


Figure 2. Study subject after cleaning at baseline visit. A) With Prophyl-Jet™. B) With tooth-brush. Disclosing solution has been used to reveal plaque.

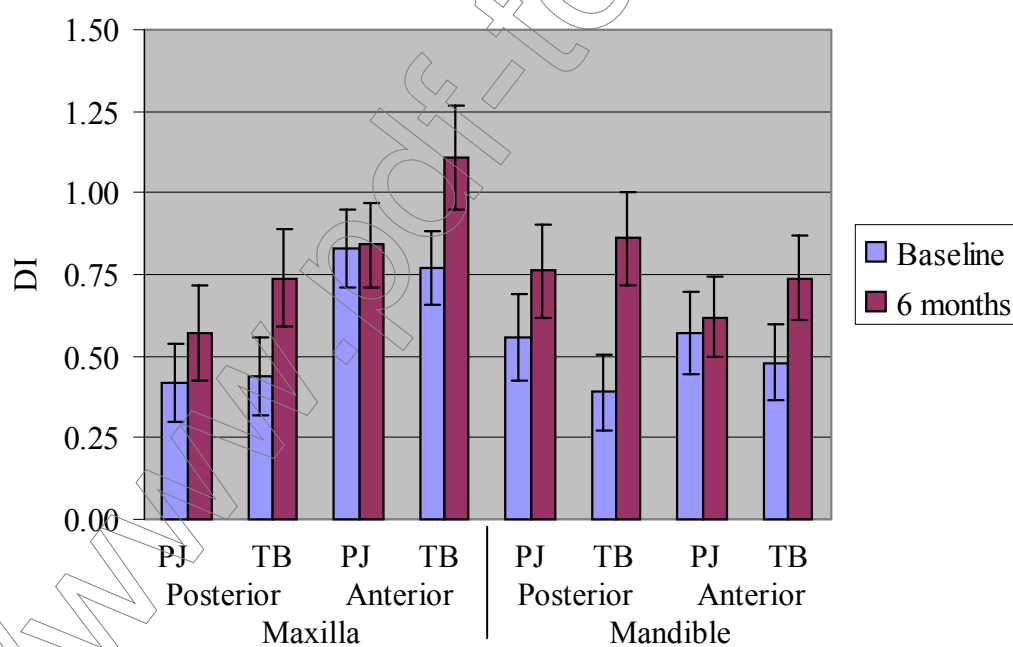


Figure 3. Decalcification Index scores (mean  $\pm$  SE) at baseline and 6 months, by region. (PJ = Prophyl-Jet™, TB = tooth-brush).

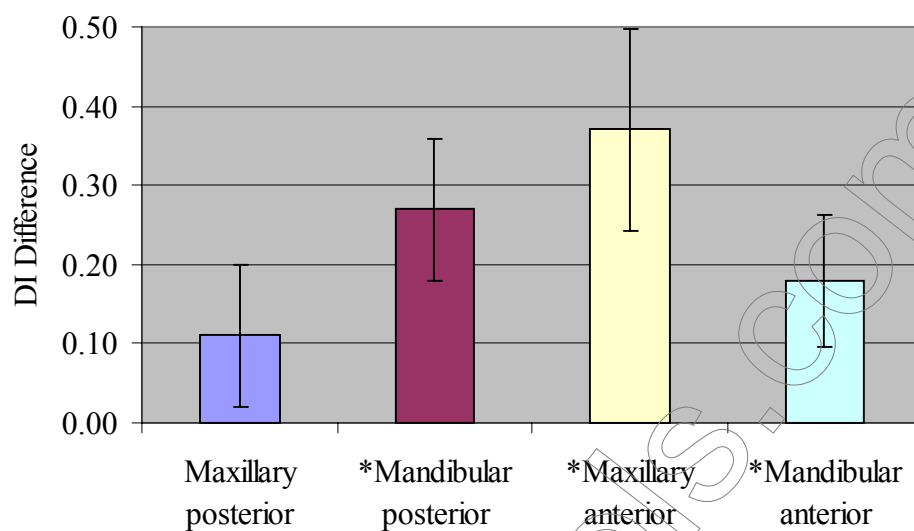


Figure 4. Difference in Decalcification Index change (mean  $\pm$  SE,  $n = 35$ ) by region. Positive DI difference indicates less increase for Prophy-Jet™. \*Significant at  $p < 0.05$



Figure 5. Study subject at completion of the six month trial. This illustrates the decreased decalcification on the (A) Prophy-Jet™ side compared to the (B) tooth-brush side.



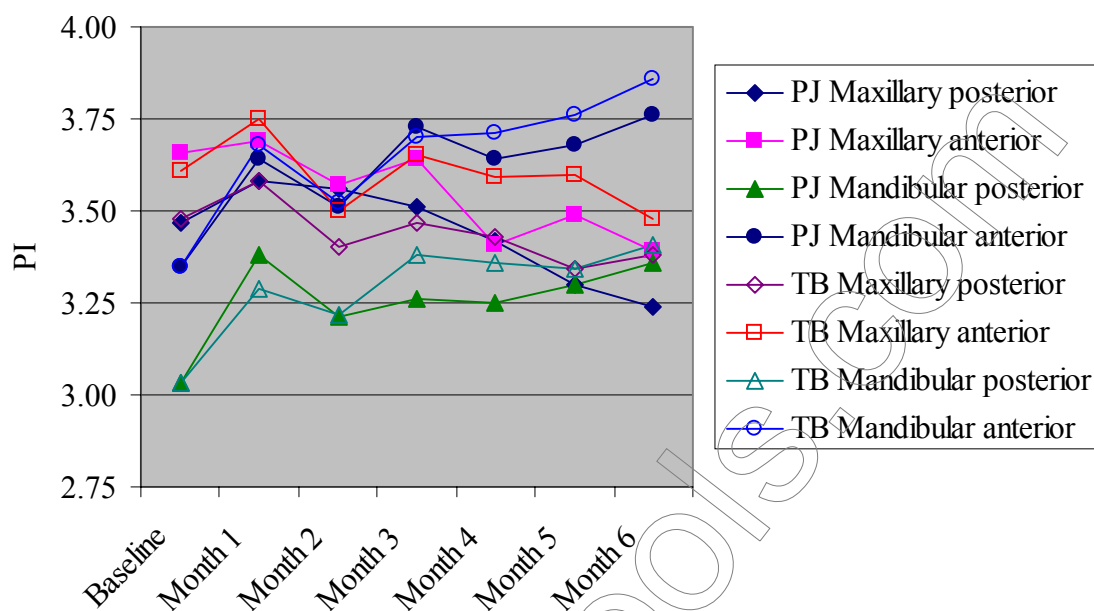


Figure 6. Monthly mean Plaque Index scores (n = 35) from baseline to 6 months, by region. (PJ = Prophy-Jet™, TB = tooth-brush)

\*Not significant at  $p = 0.07$

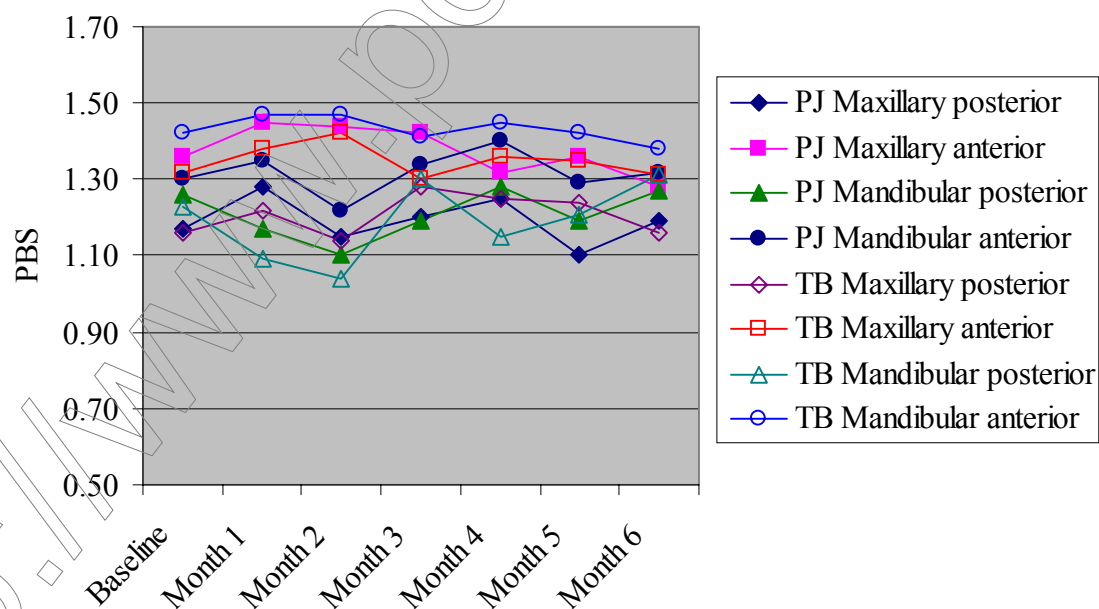


Figure 7. Monthly mean Papillary Bleeding Score from baseline to 6 months, by region. (PJ = Prophy-Jet, TB = Tooth-brush)

\*Not significant,  $p = 0.46$

Table 1. Pearson Correlation Coefficients (R values) for Decalcification Index (DI), Plaque Index (PI), and Papillary Bleeding Score (PBS).

	$\Delta$ DI TB	$\Delta$ DI PJ	$\Delta$ PI TB	$\Delta$ PI PJ	$\Delta$ PBS TB	$\Delta$ PBS PJ
$\Delta$ DI TB	1.00000	<b>0.56192</b> (p=0.0004)	0.19013 (p=0.2739)	0.25993 (p=0.1316)	-0.00457 (p=0.9792)	-0.03324 (p=0.8497)
$\Delta$ DI PJ		1.00000	0.22428 (p=0.1952)	<b>0.36608</b> (p=0.0306)	-0.10785 (p=0.5374)	-0.06599 (p=0.7065)
$\Delta$ PI TB			1.00000	<b>0.82883</b> (p<0.0001)	-0.06343 (p=0.7174)	-0.15548 (p=0.3725)
$\Delta$ PI PJ				1.00000	-0.08753 (p=0.6171)	-0.21230 (p=0.2208)
$\Delta$ PBS TB					1.00000	<b>0.55921</b> (p=0.0005)
$\Delta$ PBS PJ						1.00000

(PJ = Prophy-Jet™, TB = Tooth-brush,  $\Delta$  = change from baseline to visit 6)

## DISCUSSION

The present study was conducted as a prospective randomized controlled clinical trial on 40 orthodontic patients with full fixed appliances demonstrating visible supragingival plaque. By selecting patients in orthodontic treatment with poor oral hygiene, it was hoped that monthly Prophy-Jet™ cleanings would minimize the deleterious effects of plaque accumulation due to inadequate brushing or flossing at home. However, this patient group may not be representative of orthodontic patients as a whole. Other potential limitations include geographic sampling bias, lack of blinding due to the single operator for decalcification index, effect of extraneous factors such as manual dexterity for the patients, and selection of clinical indices

Previous studies investigated the use of the Prophy-Jet™ on orthodontic patients. Two studies by Barnes and Gerbo et al.<sup>10,11</sup> investigated the application of air-powder polishing systems in the orthodontic setting. The first study was conducted in two parts with both using the Prophy-Jet™ device. Part 1 showed that the Prophy-Jet™ was more effective in removing plaque around orthodontic appliances; and required less time than traditional rubber cup/pumice prophylaxis. The investigators noted the clinical advantage of lack of disturbance of orthodontic wires and elastic bands with the Prophy-Jet™. Part 2 of the study was performed by the bonding of brackets with composite to ten extracted maxillary central incisors and cementing of molar bands with zinc phosphate cement to ten extracted mandibular first molars. The results indicated that, while both the composite and zinc phosphate cement were exposed to the air powder spray, the surface

of the two materials maintained their integrity and their margins remained intact. The authors concluded that use of air-powder spray had no detrimental effects on orthodontic brackets or bands or their cementing agents. Other studies have suggested roughening and/or wear of dental restorative materials such as amalgam, composite, and gold foil,<sup>7,12,13,14</sup> thus, it has been recommended to avoid prolonged direct exposure of these materials to the compressed spray of slurry.

In the present study, the effectiveness of plaque debridement in a single visit by the Prophy-Jet™ was far superior to that of tooth-brushing. While PI scores were similar on both sides before cleaning, the PI scores after cleaning on the Prophy-Jet™ side were less than the tooth-brush in all areas of the mouth (Figure 1). This portion of the study was to verify previous reports of Prophy-Jet™ cleaning efficiency and to give a statistical comparison of the effectiveness of the selected cleaning methods under orthodontic clinical conditions.

The lack of any effect by the Prophy-Jet™ cleanings on monthly plaque levels and gingival inflammation can be explained by the pathogenesis of periodontal disease and the design of the study. The salivary pellicle forms within minutes to hours after professional dental cleaning, and the initial colonizers are gram positive bacteria such as *Streptococcus* and *Actinomyces* species.<sup>15</sup> Over the following days, the plaque increases in thickness and quantity as gram-negative cocci and gram-positive and gram-negative rods and filaments increase their presence. The patients included in this study were identified as having poor oral hygiene and the duration of time between monthly appointments was more than enough time for plaque levels and gingivitis to return to baseline levels. Any potential benefits of a professional cleaning would have to be

maintained by the patients in their home care in order to minimize the damaging effects of plaque accumulation on the teeth and surrounding periodontium. However, poor oral hygiene patients are the ones that would most benefit from additional hygiene measures. Therefore, we chose to study this group. The interval of one month between cleanings was selected as the minimum amount of time between most clinical visits for orthodontic patients.

Over the 6-month study, it was shown that the Prophy-Jet™ significantly decreased the formation and/or progression of decalcifications. It should be noted, however, that the decalcification process was not entirely avoided. From baseline to 6 months, the mean DI scores for the Prophy-Jet™ increased from 0.71 to 0.74 in the maxilla and 0.56 to 0.66 in the mandible. However, the tooth-brush side experienced a significantly greater increase over the six months from 0.65 to 0.95 in the maxilla and 0.44 to 0.79 in the mandible. Thus, while formation and/or progression of decalcifications was not entirely prevented, the thoroughness of the Prophy-Jet™ cleaning at monthly visits in some manner significantly disrupted the decalcification process. Possibilities for this include interference in the colonization of certain bacteria into the developing plaque on the tooth surface. Although there are more than 300 species of bacteria in plaque, most have no cariogenic potential.<sup>16</sup> Primary etiologic bacteria in dental caries include *Streptococcus mutans* and *Streptococcus sobrinus*, with *Lactobacilli* as a secondary invader involved in caries progression in enamel.<sup>17</sup> Thus, even in the presence of unaltered plaque levels and gingivitis, the monthly debridement by the Prophy-Jet™ may have altered the bacterial load by physical disruption and

prevent more deleterious organisms from colonizing and promoting the decalcification process.

The correlation of the changes in the three clinical indices from baseline to 6 months reinforces the importance of the patient's involvement in oral health maintenance. The R values of 0.56 for Decalcification Index, 0.83 for Plaque Index, and 0.56 for Papillary Bleeding Score indicate positive correlation between the changes that occurred on the Prophy-Jet™ and tooth-brush sides. Any changes for the indices on one side were paralleled by the contralateral side. This is not unexpected since this was a split-mouth study. Additionally, the positive correlation between PI changes and DI changes for the Prophy-Jet™ side demonstrates that if the patients were able to maintain the decreased plaque levels by the Prophy-Jet™ cleaning, those patients experienced less increases in decalcifications on that side. Obviously, adequate home care is critical in maintaining oral hygiene and preventing decalcifications. For the present study, the Prophy-Jet™ proved to be useful on patients that were poorly compliant with oral hygiene in preventing the excessive formation of decalcifications.

## CONCLUSIONS

This prospective clinical trial was designed to evaluate the effects of Prophy-Jet™ cleanings as compared to conventional tooth-brushing during office visits on orthodontic patients with poor oral hygiene. Based on the findings of this study, the following conclusions were reached:

- The Prophy-Jet™ is more effective than the tooth-brush at removing plaque in orthodontic patients for a single visit setting.
- Over the course of six months, the monthly Prophy-Jet™ cleanings significantly reduced the progression and/or formation of enamel decalcifications, even in the presence of unaltered monthly plaque levels and gingivitis.
- Maintenance of adequate oral hygiene at home is essential to minimizing the deleterious effects of plaque accumulation, including decalcifications.
- The Prophy-Jet™ is an effective supplement to oral health maintenance during orthodontic treatment for poor oral hygiene patients.

The mechanism for the decalcification reduction remains unclear, but could be attributed to interference in the colonization of certain bacteria by the monthly cleanings. Future studies may be designed to investigate this hypothesis by examining the differences in bacterial strains present on each side. Other factors may also be explored to minimize decalcifications and gingivitis, such as fluoride supplements, mechanical tooth-brushes, or increased frequency of professional cleaning.

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## BIOGRAPHICAL SKETCH

Jeremy Matthew Albert was born in Huntsville, Alabama, and raised in Tarpon Springs, Florida. He attended the University of Florida for his undergraduate study, with a B.S. in nutritional science. He was then admitted to the University of Florida College of Dentistry for his dental education and graduated with honors from dental school in 2000, obtaining a Doctor of Dental Medicine degree. After graduation, Dr. Albert continued his dental education at the University of Florida earning a Master of Science degree with a certificate in orthodontics in May 2003.